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OF MACROERGIC PHOSPHATES IN THE BLOOD OF RATS

V. I. Pudov and V. A. Sosenkov

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EFFECT OF IMMOBILIZATION STRESS ON THE LEVEL OF MACROENERGIC PHOSPHATES IN THE BLOOD OF RATS

V. I. Pudov and V. A. Sosenkov
Department of Pathophysiology, Kirov Medical Institute, Gorkiy

As a reaction to an unusual influence, stress is characterized by the inclusion of the body's adaptive mechanisms. Numerous experimental and clinical data have now been obtained about the reactions of various organs and systems during stress. This question has been quite insufficiently studied with regard to energy supply. We refer primarily to the evaluation of the bioenergetic state in stressful situations. 173*

In the literature there is a small quantity of works devoted to the study of the participation of macroergs, primarily tissue adenyl nucleotides of the brain, heart, skeletal muscles, and other organs, in various stress reactions [2-5, 7, 11-13]..

Since stress factor reactions must occur primarily through the energy of macroergic phosphorus compounds, we considered it interesting to study the level of adenyl nucleotides (ATP, ADP, AMP) and inorganic phosphorus in the blood in the process of stress development, as a reflection of the bioenergetic reactivity of the body as a whole.

Materials and Methods

Experiments were conducted on 79 male rats weighing 200-250g. As a stress factor model we used the generally accepted method of animal immobilization. The rats were tied to a bench for 1, 2, and 24 hours. All the indices under study were determined immediately after immobilization. For the study of the dynamics of repeated stress reaction, the rats were immobilized daily for 2 hours over the course of 7 days.

*Numbers in the margin indicate pagination in the foreign text.

Blood adenylic nucleotides (ATP, ADP, AMP) were determined by paper electrophoresis [10] in a pH 5.2 acetate buffer, with a current of 0.8mA on a 1mm cross-section phoregram exposure time 4 hours. The fractions were separated on an ultrachemoscope then eluated and placed in a ASF-q16 spectrophotometer. Sumhart's method was used to determine inorganic phosphorus in the blood. The extent of the stress reaction was tested according to the absolute quantity of lymphocytes and eosinophils in the blood, the relative weight of the thymus and adrenals, and the content in them of ascorbic acid. The material was statistically worked up [6].

Results and Discussion

The statistically reliable decrease in the absolute number of lymphocytes and eosinophils in the blood, on a background of increasing numbers of neutrophils, was noted 1 hour following immobilization. At the same time, with regard to macroergic phosphates in the blood (table), a tendency was shown for ATP in the blood to decrease and for the concentration of inorganic phosphorus to drop considerably, in comparison to these indices in intact animals.

After two hours we observed a progressing decrease in the absolute number of lymphocytes in the blood, relative to that noted in the preceding period of the study, a reliable decrease in the relative weight of the thymus, increase in the relative weight of the adrenals, and decrease in their content of ascorbic acid relative to that noted in intact animals. The concentration of ATP in the blood during this period considerably decreased relative to the norm. Together with this, a considerable decrease in the content of ADP was noted, while the quantity of AMP did not change reliably.

24 hours following continuous fixation, the markedness of the first stage of the stress reaction increased, which is documented by a considerable decrease in the relative weight of the thymus and increase in the weight of the adrenals. The absolute content of lymphocytes decreased even more, while that of neutrophils

increased. At the same time the quantity of ATP continued to progressively decrease. The content of ADP and AMP changed only slightly, while that of inorganic phosphorus grew, but did not reach normal levels.

1 and 2 days following daily immobilization for two hours, the concentrations of ATP, ADP, and inorganic phosphorus remained at a lower-than-normal level, but ATP content was 1.31 mg% higher than in rats constantly immobilized for 24 hours. After 3 sessions of immobilization, a tendency was noted for the ATP and ADP levels to increase while there was a lowered AMP concentration.

After four days, ATP content did not essentially differ from its concentration in the preceding period of the study, and the level of AMP increased somewhat. A considerable drop in blood inorganic phosphorus content was noted.

On the fifth day of immobilization, an increase in all blood adenylic system indices was noted.

6 and 7 days later, full normalization was observed in the content of blood macroergic phosphates, with the exception of inorganic phosphate, which previously had been below normal. Normalization of leucogram indices was also noted in this period, which was reflected in a considerable growth in the absolute quantity of lymphocytes and eosinophils relative to the initial periods of investigation. However, the relative weight of the thymus was considerably below normal. Ascorbic acid content in them was depressed relative to normal levels. All of this is evidence of the presence of stages of resistance in the general adaptational syndrome [1].

Hence, at this stage almost full normalization was observed, except for inorganic phosphorus level and blood adenylic system indices, which is evidence of renewal of energetic homeostasis in this period, despite the daily sessions of immobilization..

After 15, 30, 60, and 90 days from the beginning of immobilization, blood adenylic system indices were within normal limits, with the exception of the decreased concentration of inorganic phosphorus. This apparently indirectly indicates the lack of a depletion stage for the given form of experiment.

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Analysis of the obtained results, and also the changes we established previously [8,9] with regard to the adenylic system of the blood during induction of tumors by 3,4-benzpyrene, gives the impression of definite parallelism in the results. Thus, in the initial stages of carcinogenesis, a drop is observed in the content of ATP in the blood, and 10 days following injection of a carcinogen a stable normalization is observed, and only in the final stages of tumor growth does the concentration of ATP in the blood decrease considerably. The initial decrease in ATP quantity may be conditioned by stress factor reaction to the injected carcinogen. Consequent normalization may be associated with compensator mechanisms in the central nervous system and in energy metabolism, which become insufficient in the final stage of the growth and development of tumors.

ADENYL NUCLEOTIDES IN THE BLOOD IN IMMOBILIZATION STRESS DYNAMICS ($M+m$)

Substance under Study (mg%)	Control (intact) (33)	Periods of Study					
		1hr (15)	2hrs (13)	24hrs (13)	1day(20)	2days(17)	3days (18)
ATP	12,97±0,98	11,54±0,55	9,87±1,08*	15±1,00**	9,46±0,60*	9,08±0,84*	10,72±0,74
ADP	3,24±0,39	4,02±0,30	0,94±0,25*	1,37±0,27*	1,80±0,32*	2,08±0,22*	2,64±0,34
AMP	2,43±0,21	2,80±0,29	2,80±0,53	2,50±0,38	1,78±0,35	1,97±0,26	2,27±0,29
Inorg. Phosphor..	6,55±0,32	3,65±0,45*	3,8±0,31*	5,8±0,26**	3,6±0,67*	4,2±0,42*	1,28±0,15*
						5,2±0,61	1,84±0,25
							2,8±0,41**

Substance under Study (mg%)	Control (intact) (33)	Periods of Study					
		5days(18)	6days(16)	7days(19)	15days(16)	30days (18)	60days (16)
ATP	12,97±0,98	11,38±0,60	12,82±0,46	13,14±0,82	12,68±0,64	12,38±0,48	12,72±0,62
ADP	3,24±0,39	3,14±0,31	3,72±0,14	3,48±0,18	2,96±0,26	3,08±0,32	3,26±0,29
AMP	2,43±0,21	2,32±0,19	2,18±0,34	2,52±0,20	2,06±0,28	2,24±0,23	2,12±0,30
Inorg. Phosphor.	6,55±0,32	4,6±0,70**	4,5±0,66	5,2±0,59	4,4±0,65	5,3±0,54	3,1±0,22*
							5,0±0,29

REFERENCES

1. Gorizontov, P. D., Pat. fiziol., 2, 3-6 (1974).
2. Zor'kin, A. A., V. I. Nigulyanu, L. T. Lysyy et al., in: Stress i yego patogeneticheskiye mekhanizmy [Stress and its Pathogenetic Mechanisms], Kishinev, 1973, pp. 23-24.
3. Korkach, V. I., Byull. eksper. biol., 8, 44-46 (1971).
4. Kiselev, G. V., T. E. Rayze, L. N. Fedorenko, Byull. eksper. biol., 8, 31-44 (1971).
5. Lemus, V. B., V. V. Davydov, V. M. Bragin, in: Stress i yego patogeneticheskiye mekhanizmy [Stress and its Pathogenetic Mechanisms], Kishinev, 1973, pp. 221-222.
6. Montsevichute-Eringene, E. V., Pat. fiziol., 4, 71-78 (1964).
7. Pogodayev, K. I., in: Stress i yego patogeneticheskiye mekhanizmy, [Stress and its Pathogenetic Mechanisms], Kishinev, 1973, pp. 34-35.
8. Pudov, V. I., in: Reaktivnost' organizma i opukholevyy rost (Trudy med. in-ta) [Body Reactivity and Tumoral Growth (Medical Institute Proceedings), 51st Edition, Gor'kiy, 1974, pp. 32-35.
9. Pudov, V. I., 6-ya Povolzhskaya konferentsiya fiziologov s uchastiyem biokhimikov, farmakologov i morfologov [6th Volga Conference of Physiologists and Biochemists, Pharmacologists, and Morphologists], Vol. 2, Cheboksary, 1973, pp. 122-123.
10. Rogozkin, V. A., and L. I. Komkova, Ukr. biokhim. zh., 5, 709-712 (1961).
11. Ehrhart, H., and P. Schwandt, Enzyme, 13, 77-89 (1972).
12. Jones, P., Brit. J. Cancer, 23, 629-633 (1969).
13. Lolley, R., and F. Samson, Am. J. Physiol., 202, 77-82 (1962).

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